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Commission canadienne de sûreté nucléaire

CNSC Staff Annual Report for 2000 on the Canadian Nuclear Power Industry

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SUMMARY

This report is the Canadian Nuclear Safety Commission (CNSC) staff assessment of licensees' performance across the Canadian nuclear power industry in 2000.

CNSC staff assess the performance of each licensee in ten licensing and safety areas, according to one of three categories – "acceptable", "conditionally acceptable" or "unacceptable".

This year, no licensing and safety area or sub-area was judged to be unacceptable.

In the safety area of operating performance all stations were assessed as acceptable. There were no *serious process failures* or major events at any station and CNSC staff has noted a steady improvement in the conduct of operations.

In the safety area of equipment fitness for service, the following programs were assessed as conditionally acceptable: maintenance, periodic and in-service inspections, environmental qualification and fire protection. CNSC staff has noted that all licensees are proceeding with fire protection improvements with notable progress at the Darlington and Pickering sites. However, the environmental qualification program is being slowly implemented because most of the fieldwork requires the reactor to be shutdown. Once again this year, a challenge to the industry remains the reduction of maintenance backlogs.

Under the safety area of performance assurance, CNSC staff continue to assess that the extent of corporate oversight and the degree of implementation of quality assurance programs throughout the industry must improve.

In the safety area of training, examination and certification, the industry has been unable to deliver a valid re-qualification test method for certified staff, although all licensees have been working cooperatively on its development since 1998.

On a positive note, the industry continues its strong performance in the safety areas of emergency preparedness, environmental performance and radiation protection. In 2000, CNSC staff evaluated the emergency preparedness programs and full scale emergency exercises at Bruce, Gentilly-2 and Point Lepreau. CNSC staff found these exercises were well run with only minor deficiencies noted. Environmental releases and radiation doses to the public for all stations continue to be well below regulatory limits. As well, there were no reported unplanned releases of radioactive substance or other controlled substance to the environment from any station and no worker received a radiation dose in excess of regulatory limits.

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INTRODUCTION

The Canadian nuclear power industry is concentrated in the eastern part of the country. Figure 1 shows the location of each site, the number and generating capacity of the reactors, and the initial start-up date, licence holders and expiry date of licences at the time the report was prepared. Of the 22 licensed reactors, eight have produced little or no power since 1998. The four reactors at Bruce A are defuelled and in a *layed-up state*. The four reactors at Pickering A are in a layed-up state with fuel resident in the reactor core. Bruce B, which comprises four 915 megawatt CANDU reactors, is currently limited to operating at or below 90% power. Darlington, with four 935 megawatt CANDU reactors, is limited to 98% power. The remaining stations are nominally operating at 100% power.

To meet the legal requirements of the *Nuclear Safety and Control Act* and its Regulations, licensees are expected to implement programs which ensure that station operation does not pose an unreasonable risk to the health and safety of workers, the public and the environment.

CNSC staff assess every station's performance against codes, standards and legal requirements, including the conditions of operating licences. About 130 CNSC staff members are authorized as inspectors of various aspects of the Canadian nuclear power industry. Of these, 25 reside at the sites to monitor facility performance. Other staff with expertise in areas such as radiation protection, quality assurance, security and emergency preparedness, also conduct periodic inspections.

This report is the integration of information gathered through CNSC staff assessment activities of the Canadian nuclear power industry's operational safety in 2000. The report makes comparisons where possible, shows trends and averages and highlights significant issues that pertain to the industry at large. Principal sections of the report align with CNSC staff standard table of contents for power reactor re-licensing *Commission Member Documents (CMD)*. Refer to Figure 4 for a layout of the main areas and sub-areas that are assessed in this report. Detailed information on issues can be found in the re-licensing CMD's for each facility.

The report's conclusions are supported by facts gathered by CNSC staff inspections and document reviews, event reviews and studies of performance indicators. Common findings, event causes and trends across the industry are presented.

Figure 1: Locations of Nuclear Power Station Sites in Canada

STATION DATA

	Bruce A	Bruce B	Darlington	Gentilly- 2	Pickering A	Pickering B	Point Lepreau
Licensee	Ontario Power Generation	Ontario Power Generation	Ontario Power Generation	Hydro-Québec	Ontario Power Generation	Ontario Power Generation	New Brunswick Power
Reactor Units	4	4	4	1	4	4	1
Gross Electrical Capacity per Reactor (in Megawatts)	904	915	935	675	542	540	680
Start-Up	1976	1984	1989	1982	1971	1982	1982
Licence Expiry	2002-08-31	2001-10-31	2003-02-28	2002-12-31	2001-03-31	2001-03-31	2002-10-31

Through these assessment activities and ongoing document reviews, CNSC staff identify strengths and weaknesses in licensees' performance and raise issues requiring attention or corrective action. In areas where assessments took place in 2000, staff assessed performance according to the three categories shown in Figure 2. CNSC correspondence has already informed licensees of the need for corrective action to improve any area assessed to be less than acceptable.

Figure 2: Performance Assessment Categories

Acceptable	No significant deviation from requirements or expectations. Issues are being addressed in an appropriate manner and are considered to have no short-term impact on safety. This rating may also be used for a topic that was previously "conditionally acceptable" when there is evidence of improvement and the licensee is actively working toward meeting the conditions.
Conditionally Acceptable	A significant weakness in the program or performance has been observed. However, clearly defined conditions, with a time frame, have been identified and the licensee has committed to address the problems. Any appropriate compensating measures have been taken so that this weakness does not pose an immediate safety concern.
Unacceptable	There is a major weakness in the program or performance or a significant weakness has not been addressed in a timely manner. The licensee has not taken appropriate compensating measures or provided an alternative plan of action.

A glossary of technical terms used in this report is provided in annex. Terms are *italicized* on first reference.

Past CNSC staff assessments, research reports, Commission Member Documents, communiqués, information bulletins, notices and other documents about power reactor licensing are available to the public at the CNSC public library in Ottawa or via the CNSC's Web site at *www.nuclearsafety.gc.ca*. Requests for information should be directed to the Canadian Nuclear Safety Commission, P.O. Box 1046, Station B. Ottawa, Ontario, Canada, K1P 5S9, via e-mail to *info@cnsc-ccsn.gc.ca* or by calling (613) 995-5894 or 1-800-668-5284.

OPERATING PERFORMANCE

A review of operating performance includes sub-areas such as CNSC site staff day-to-day review of station operation, compliance to CNSC requirements for reportable events, action item management, approval process and outage management.

In 2000, the industry continues its strong performance in day-to-day station operation, technical surveillance and outage management. Overall, CNSC staff assess all licensees in the safety area of operating performance as acceptable.

REVIEW OF STATION OPERATION

This year, of the 14 reactors available to provide electrical power, the industry operated approximately 81 % of the time; the reactors were in, or being placed in, a *guaranteed shutdown state* for the remaining 19 % of the time. All units at Pickering A and Bruce A remained in a layed-up state.

There were no serious process failures at any station, this continues to be an industry strength in operating performance.

CNSC staff monitor a performance indicator called "Number of Unplanned Reactor Power Transients". This indicator shows the number of manual or automatic power reductions from actuation of either the shutdown, the *stepback* or *setback* systems. Unexpected plant shutdown and restart may be indicative of problems within the plant and place unnecessary strain on operational systems, thus there is a benefit to safety for the station to operate at constant power level without interruption. As shown in Table 1, there were five reactor trips, two manual and three automatic, in response to testing errors, failed equipment or a false trip signal caused by a lighting strike. There were also five automatic reactor power reductions using the regulating system's stepback or setback function in response to various system failures. CNSC staff assessed none of these events as serious, therefore, CNSC staff judged station operation at all sites to be acceptable.

Table 1: Number of Unplanned Transients in 2000

	Approximate Reactor Operating Hours for 2000	Reactor Trip	Reactor Stepback	Reactor Setback
Multi-Unit Stations				
Bruce B	29,900	1	3	1
Darlington	32,350	1	0	0
Pickering B	21,750	2	0	1
Single-Unit Stations				
Point Lepreau	7,100	1	0	0
Gentilly-2	7,900	0	1	0
Industry Total	**99,000**	**5**	**4**	**2**

CONDUCT OF OPERATIONS

CNSC staff routinely carry out inspections, in the field and in the main control room, on systems and operational practices as part of their compliance activities. In addition, CNSC staff routinely audit licensee's compliance with their documented programs. During control room inspections, CNSC staff monitor control room documentation, panel readings and operator work performance. In the field, CNSC staff verify that the plant is well maintained.

Once again in 2000, CNSC staff observed steady improvement across the industry in the conduct of operations. This improvement is reversing a trend of poor performance from previous years. However, at Darlington, CNSC staff is concerned with the many distractions licensed operators face in the control room, particularly interference with three-way communication required to accomplish certain operational manoeuvres. In addition, at most sites, CNSC staff would like to see more evidence of program integration and better document control. CNSC staff also require improvement in licensee's staff support facilities and equipment. Therefore, CNSC staff assess all licensees in the sub-area of conduct of operations as conditionally acceptable.

TECHNICAL SURVEILLANCE

CNSC staff expect licensees to monitor and report on system performance. CNSC staff also expect that maintenance and testing practices be adjusted in accordance with industry advances or in response to declining system performance. Therefore, CNSC staff require all licensees to have a technical surveillance program which helps to detect problems and ensure optimum system reliability and availability.

In 2000, OPG stations improved and further standardized their technical surveillance programs. CNSC staff found that technical surveillance at OPG sites emphasized continuous monitoring, assessment, and accountability for the condition of systems by the licensee's engineering staff. Across all OPG stations a set of system performance measures is now being routinely reported for each of the safety-related systems in quarterly health reports. Last year, CNSC staff reported delays in Point Lepreau establishing a formal technical surveillance program. This year, the revised system health monitoring program is still not fully implemented. Therefore, CNSC staff assess OPG sites in the sub-area of technical surveillance to be acceptable while Point Lepreau is assessed as conditionally acceptable. There was no assessment for Gentilly-2 in this sub-area.

REPORTABLE EVENTS

As the facility operates through its life, events occur such as process failures, unplanned reactor shutdowns, licence violations, that are an important source of information. CNSC *Regulatory Policy Statement* R-99 requires all licensees to report these events so that lessons can be learned and be used to prevent these events from recurring. CNSC staff monitor licensees to ensure that events are promptly detected, reported and contain information that is required by station licences. CNSC staff review each event and follow up on any that may be significant. Events that are not individually significant are collected and assessed for trends.

This year, a strong point throughout the industry was that all stations operated without any major events that required an independent CNSC staff investigation.

CNSC staff also found that although not all events were promptly reported they met content requirements. CNSC staff has noted that licensee staff are more aware of reporting requirements. Also, CNSC staff noted an improvement in the management commitment to follow up on previous events and remain satisfied with licensee corrective plans. At Gentilly-2, CNSC staff would like to see improvement in Hydro-Québec's staff follow-up of reportable events. Therefore, CNSC staff assess OPG sites and Point Lepreau in the sub-area of reportable events to be acceptable, while Gentilly-2 is conditionally acceptable.

ACTION ITEM MANAGEMENT

CNSC staff follow issues of regulatory importance using the action item program. When an issue with negative impact on risk has been identified, CNSC staff raise an action item. Action item management is used to bring the issue to the attention of the licensee and to solicit corrective action by a predetermined date. CNSC staff expect all licensees to have a process in place to manage the action item requests. There were approximately 300 open action items assigned against licensees at the end of 2000. CNSC staff review has found that a common problem throughout the industry has been the follow up and closure of action items. CNSC staff is also concerned that some action items identified as being open did not appear in any licensee work program documentation. CNSC staff has regular meetings with licensees to review open action items and is satisfied with the progress to date on most of these issues. This year, CNSC judge all licensee performance in the sub-area of action item management to be acceptable.

APPROVAL PROCESS

The licensee is required to obtain CNSC approval, in writing, to make changes to certain documents, components or systems. Once submitted, CNSC staff review these approval requests and respond accordingly. CNSC staff expect all approval requests to contain accurate and sufficient information to be able to make an informed decision. For the most part all licensees have complied with the requirement to submit requests for approval, however, there is room for improvement in the timing and the quality of these submissions. Particularly for maintenance outages, many submissions by licensee staff have requested approval within an inordinately short time frame and the quality of submissions has been below expectation. Therefore, this year, CNSC staff assessed all licensees as conditionally acceptable in this sub-area.

OUTAGE MANAGEMENT

CNSC staff expect that when a maintenance outage occurs the plant will remain in a safe state throughout the outage. Therefore, CNSC staff monitor licensee outages to ensure reactor safety principles are maintained. As well, CNSC staff verify that licensee station programs such as maintenance, radiation protection and dose control are followed throughout the outage. For safety significant work, CNSC staff review the licensee's outage planning, management of discovered work, outage organization and implementation. Finally, as the outage nears completion, CNSC staff review the start-up and return to service of the reactors.

CNSC staff believe that licensees have put together the necessary elements to safely execute maintenance outages. CNSC staff reviews have found that the initial outage scope contains the safety related work needed to be performed on the reactors. In addition, CNSC staff has seen improvement from previous years in maintenance, outage resources and planning. However during the execution of the outages, CNSC staff still feel that too much of the safety related work is being deferred to future outages. This is due to lingering problems with work coordination, availability of spare parts and the

discovery of new work. On a positive note, most sites have good control over radiation safety and doses to workers during outages, except for Gentilly-2, where CNSC staff noted weaknesses in Hydro-Québec's staff adherence to radiation protection procedures. CNSC staff found that licensees correctly apply and maintain the reactors in the *guaranteed shutdown state* with proper management of *heat sinks*. Licensees implement effective foreign-material exclusion procedures that prevents stray material from being left in or accidentally entering opened systems and generally all stations, follow good housekeeping practices. However, CNSC staff would like to see improvement in the reactor return-to-service at the end of the outages, particularly a reduction to the frequent changes to the reactor start-up plans. Overall, CNSC staff assess all licensees in the sub-area of outage management to be acceptable.

NON-RADIOLOGICAL HEALTH AND SAFETY

CNSC staff expect licensees to follow accepted industrial safety requirements to keep the number of accidents to workers as low as possible. In order to verify this, CNSC staff monitor a performance indicator called "Accident Severity Rate". This indicator measures the total number of days lost to injury for every 200,000 person hours worked at a site (2000 results are shown in Table 2). This year, a review of accidents that resulted in lost time from work showed that all injuries were minor and that there were no accidents which demonstrated unsafe licensee behaviour, therefore, CNSC staff assess all licensees in the sub-area of non-radiological health and safety as acceptable.

Table 2: Accident Severity Rate for 2000

Site	Days Lost	Hours Worked	Accident Severity Rate
Point Lepreau	6	1,277,410	1
Bruce A and B	122	6,423,230	4
Pickering A and B	124	6,327,610	4
Darlington	171	4,279,730	8
Gentilly-2	39	1,202,400	6
Industry Total	**462**	**19,510,380**	**5**

SAFETY ANALYSIS

Safety analysis for power reactors are performed by the licensee to verify that regulatory requirements, such as dose limits, are met. Safety analysis results define the safe operating envelope for the reactors and verify that safety systems can appropriately perform their mitigating roles during design basis accidents. CNSC staff expect all licensees to perform a comprehensive analysis which shows that the station safety features meet all specified performance criteria with adequate margin to cover uncertainties in the methods of analysis. CNSC staff also expect that the safety analysis follow a well documented auditable process and be periodically updated to incorporate new analysis or changes due to operational experience.

The CNSC staff review of safety analysis involves two main aspects, the technical review and the quality assessment. The technical review mainly consists of the assessment of the methodologies and models used in the analysis. The quality assessment verifies that appropriate standards and procedures have been followed and ensures that the codes have been properly validated.

This year, CNSC staff technical reviews identified a number of uncertainties and potential shortcomings in the safety analysis. Although, none were considered to constitute an immediate safety concern, the licensees have committed to address these outstanding issues either by providing additional information, improving the computer code modeling, replacing current computer codes with more advanced ones, or taking operational measures to compensate for shortcomings in the analysis. Specific actions that have been taken include the introduction of new reactor physics codes and restrictions on operating limits at some stations.

The safety report documents the stations' safety analysis. All licensees are required to update the safety report every three years to ensure that it continues to reflect the design and operation of the reactors and any modifications to the safety analysis. In 2000, CNSC staff reviews originally found that proposed safety report update plans for OPG stations were unacceptable. Subsequently, OPG staff has submitted a comprehensive update program that CNSC staff found to be adequate.

In previous years, CNSC staff has raised the importance of computer program validation by opening a generic action item requiring all licensees to provide evidence that their computer codes have been properly validated. In response, licensees have developed a comprehensive framework for computer program validation. CNSC staff is satisfied with the results to date.

Given the steady improvement in the status of the safety report update issue and in the licensees' handling of generic action items, CNSC staff assess all licensees' performance in the area safety analysis as acceptable.

EQUIPMENT FITNESS FOR SERVICE

The safety area of equipment fitness for service includes those programs which impact on the physical condition of the various systems and components in the plant. CNSC staff expect all licensees to demonstrate that station systems are designed, operated and maintained such that they will perform their safety function when required to do so. Most programs included in this safety area have been assessed as acceptable, except the following programs which have been assessed as conditionally acceptable:

- maintenance,
- periodic and in-service inspections,
- environmental qualification, and
- fire protection.

Licensees are aware that these programs require attention but improvement has been slow. This lack of progress has led CNSC staff to an overall assessment for all licensees in the safety area of equipment fitness for service of conditionally acceptable.

DESIGN ADEQUACY

The design adequacy of a nuclear station refers to the ability of its systems to meet their design intent given new information arising from operating experience. When necessary, CNSC staff raise an action with the licensee if a new failure or degradation mechanism has been uncovered. The licensees are then requested to take interim compensatory measures to ensure that the safety margins of the reactor are maintained. The issue is then monitored by CNSC staff until it has been satisfactorily resolved.

In 2000, CNSC staff did not raise any new design adequacy issues and assessed that the existing issues do not result in significant safety concerns. CNSC staff is also satisfied with the progress of existing issues and therefore assess all licensees in the sub-area of design adequacy as acceptable.

MAINTENANCE

CNSC staff expect licensees to be able to maintain their station systems in a state that conforms with the current design and analysis. To meet this expectation, the licensees require a maintenance program with the necessary organization, equipment and procedures. In addition, the licensee must demonstrate that other related programs such as reliability, environmental qualification, training, technical surveillance, procurement and planning support this maintenance requirement. CNSC staff review each specific program as outlined in other sections of this report, as well, CNSC site staff routinely report on licensee planning, work practices, training, self assessment and documentation.

In 2000, CNSC staff found that licensees made improvements in most maintenance areas, particularly in work management, such as, Point Lepreau's introduction of a new maintenance group designed to increase productivity by removing inefficiencies in the work review process. However, as in previous years the biggest challenge to the industry remains the reduction of corrective and preventive maintenance backlogs. These backlogs will not be eliminated unless substantial productivity gains are achieved. In addition, at most stations, CNSC staff would like to see improvements in maintenance procedures and procedural adherence. At Gentilly-2, CNSC staff continue to assess maintenance as acceptable while the remaining stations are assessed as conditionally acceptable.

PERIODIC AND IN SERVICE INSPECTIONS

Licensees carry out periodic and in-service inspections to confirm that equipment important to safety remains fit for service. As inspection findings uncover degradations, CNSC staff expect licensees to establish strategies for mitigating or fixing the problems or, if appropriate, replacing the components.

This year, major emphasis was again on *steam generator* tubes, *pressure tubes* and *feeder* piping inspections, as almost all other high pressure nuclear components have exhibited few signs of degradation.

At OPG stations periodic inspections showed the main reasons for degradation in its steam generator tubes were fretting and pitting. Failure of a small number of steam generator tubes does not pose a significant safety concern. Nevertheless, assurance that steam generator tubes have not deteriorated to the point where a large number could fail simultaneously can only be obtained through detailed monitoring and management. OPG staff has proposed fitness-for-service guidelines and life-cycle management programs to address these degradation processes, which are being reviewed by CNSC staff. CNSC staff believe that information generated through these fitness-for-service guidelines and life-cycle management programs will provide a good base to assess the fitness of steam generators throughout the industry.

There were few problems with the Gentilly-2 and Point Lepreau steam generators in 2000.

The most significant components of the licensees' inspection programs monitored by CNSC staff is pressure tubes. Failure of any pressure tube is a significant safety concern, therefore, tubes with potential flaws should be replaced prior to any breaks occurring. Although licensees are continuing research to establish a firmer technical basis for pressure tube rejection and replacement, further increases in deuterium pickup rates in pressure tubes, which make the tubes less ductile, have been observed in some reactors. CNSC staff feel that the fitness-for-service guidelines for pressure tubes remains a major weakness in licensees' inspection programs, because of the inability of the current guidelines to adequately define criteria for rejecting a pressure tube.

After many trouble free years of service, nondestructive inspections revealed unexpectedly large reductions in the wall thickness of some feeder pipes. Extensive feeder piping inspections at Darlington indicate that the corrosion rate is increasing and many feeder pipes have lost almost 20% of their original wall thickness at the outlet elbow. Inspections at Pickering revealed similar concerns but with lower corrosion rates. Although feeder piping remains fit for service in the short-term, the expected design life of some feeders may be halved if the current rate of degradation continues. This year, OPG submitted long-term monitoring and fitness-for-service criteria for feeders, which CNSC staff is reviewing. Gentilly-2 and Point Lepreau previously submitted their programs and have been reporting results for several years.

Overall, CNSC staff assessed the performance in conducting periodic and in-service inspections to be conditionally acceptable at all stations.

RELIABILITY

CNSC staff expect that systems whose failure impacts on the risk of a release of radioactivity be part of a reliability program. Licensees must establish a program that includes, setting of reliability targets, performing reliability assessments, testing and monitoring, and reporting the results of these activities. CNSC staff reviews of reliability mainly consists of:

- reliability model and data verification,
- safety system availability,
- testing program, and
- reporting.

In 2000, all of the special safety systems met their regulatory targets for availability with the exception of Darlington's second shutdown system, which failed to meet its target because of a faulty check valve. OPG staff has taken appropriate action to rectify the problem. The performance of safety support systems was good and there were no system failures that contributed significantly to an increase in risk at the stations. In addition, all licensees completed their annual reliability report on time and CNSC staff review found that all licensees adhered to their mandatory testing programs. OPG has completed probabilistic risk assessments for the Darlington, Pickering A and Bruce B stations and work is in progress on the Pickering B risk assessment. These assessments increase the ability of a licensee to identify the risk significance of systems and components, and modify operating and maintenance practices accordingly. Although not a regulatory requirement, CNSC staff is encouraging all licensees to develop this powerful reliability tool.

Table 3 shows the CNSC performance indicator "Number of Missed Mandatory Safety System Tests". This indicator measures the ability of licensees to successfully complete all required routine tests on systems related to station safety. There are several thousand of these tests performed annually. CNSC staff review each test missed and the licensee is required to provide an event report. At Darlington, the licensee uncovered 20 past due checks on a power supply, however, this omission had minimal impact on system availability and of the remaining tests missed in 2000, none significantly impacted on system availability. Therefore, as in previous years, CNSC staff continue to assess all licensee's reliability program as acceptable.

Table 3 Number of Missed Mandatory Safety System Tests in 2000

Station	Special Safety Systems	Standby Safety Systems	Safety Related Process Systems
Bruce B	1	0	0
Darlington	3	5	24
Pickering B	5	1	0
Gentilly-2	0	0	0
Point Lepreau	2	0	1

ENVIRONMENTAL QUALIFICATION

The environmental qualification program provides assurance that equipment needed to mitigate the consequences of an accident will function when exposed to the harsh conditions an accident may create. This assurance must exist for the life of the equipment. Over the years, the environmental qualification process has not been well documented and there have been inconsistencies in the level of qualification provided. Recently, the industry has made significant progress in developing the environmental programs, and in 2000, the program has continued to evolve from the engineering to implementation phases. However, most environmental qualification fieldwork requires the reactors to be shutdown, consequently, implementation takes considerable time. For reactors who had outages in 2000, licensees continued to replace a number of components to correct known environmental qualification anomalies. For example, at the multi-unit station of Pickering B significant environmental qualification-related work was completed during the 2000 vacuum building outage.

As mentioned in the 1999 report, a common issue affecting Bruce A, Gentilly-2, Pickering A and Point Lepreau is the existence of polyvinyl chloride-insulated cables in special safety and support systems inside *containment*. Tests have shown that the cable insulation might fail in harsh environments. While this issue is being resolved at the Pickering station through a cable replacement program, it remains under study, and outstanding, at the other sites. To ensure continued progress, CNSC staff has developed a standard environmental qualification licence condition.

Although improvements have been made, pending resolution of the above issues, CNSC staff continue to assess all licensees in the sub-area of environmental qualification as conditionally acceptable.

NUCLEAR PLANT LIFE ASSURANCE

Safety-related structures and systems in nuclear power plants must remain effective as the plant ages. Several years ago, CNSC staff raised a generic action item to cover the subject of ageing. CNSC staff expect licensees to identify any component subject to ageing which is not covered by other plant programs, such as environmental qualification or periodic inspections. Once these components are identified they are to be integrated into existing plant maintenance activities to ensure continued safe operation as the plant ages. At OPG stations, the ageing management program is part of the integrated improvement project. Expert panels are reviewing systems to identify components subject to ageing and have modified some procedures to accommodate their maintenance. At Point Lepreau and Gentilly-2, staff are following a similar approach in preparation for their proposed plant life extension projects.

In 2000, CNSC staff noted an increase in ageing related failures at some stations, such as at Bruce B, where OPG staff required additional maintenance on the class 1 electrical system to maintain its reliability. However, CNSC staff assess all licensees in the sub-area of nuclear plant life assurance as acceptable.

FIRE PROTECTION

Fire protection programs at nuclear sites minimize the risk due to fire to workers, the public and to nuclear safety. In previous years, CNSC staff, with the aid of contractors, reviewed fire protection provisions at all stations. Based on these reviews, CNSC staff requested that all licensees make physical and emergency response team improvements at their sites. In addition, CNSC staff implemented standard licence conditions requiring compliance with Canadian National codes and with CANDU fire protection standards. A clause in the standard licence condition requires licensees to complete a fire hazard assessment. To date, Gentilly 2, Pickering A and Bruce B have completed this assessment, while the other sites are behind schedule. CNSC staff has noted that all licensees are proceeding with fire protection improvements with notable progress at Darlington with the installation of new fire suppression systems and at Pickering with the installation of new fire detection systems. However, pending implementation of necessary fire protection improvements, CNSC staff assess all licensees in the sub-area of fire protection as conditionally acceptable.

CHEMISTRY CONTROL

Chemistry control is the program that monitors the quantities of chemicals and initiates corrective action to limit the quantities of impurities in systems within the plant. Loss of control of chemistry and the associated mitigation actions could lead to a negative impact on nuclear safety such as an unplanned change in reactivity, reduction of heat transfer coefficients, corrosion of equipment or activation product formation.

CNSC staff monitor two chemistry performance indicators, the "Chemistry Index" and the "Compliance Chemistry Index" (year 2000 results are shown in the Table 4). The purpose of the chemistry index is to indicate the licensees' long-term control of important chemistry parameters. The purpose of the compliance chemistry index is to monitor the licensees' performance in meeting CNSC requirements for safety-related chemical parameters.

At Pickering B, CNSC staff noted that some chemical parameters were problematic throughout the year. At Bruce B, CNSC staff would like to see improvement in some chemistry compliance parameters which trended low. CNSC staff found that chemistry was well controlled at Darlington, Gentilly-2 and Point Lepreau in 2000. Consequently, CNSC staff assessed all licensees in the area of chemistry performance to be acceptable.

Table 4 Chemistry Indices 2000

Station	Unit	Chemistry Index	Compliance Chemistry Index
Darlington	Unit 1	90	99
Darlington	Unit 2	94	99
Darlington	Unit 3	93	99
Darlington	Unit 4	94	99
Bruce B	Unit 5	94	93
Bruce B	Unit 6	91	89
Bruce B	Unit 7	91	90
Bruce B	Unit 8	89	88
Gentilly-2		90	98
Point Lepreau		93	95
Pickering B	Unit 5	84	92
Pickering B	Unit 6	84	91
Pickering B	Unit 7	87	88
Pickering B	Unit 8	83	94
Industry Average		**90**	**94**

PERFORMANCE ASSURANCE

The safety area of performance assurance consists of those activities that enable effective human and organizational performance through the design and implementation of management programs, standards, processes and procedures at the plant.

This year, CNSC staff has assessed all licensees in the safety area of performance assurance as conditionally acceptable. This rating is mainly due to the improvement required in the quality assurance programs at the stations. CNSC staff continue to assess that the extent of corporate oversight and the degree of implementation of quality assurance programs throughout the industry must improve.

QUALITY ASSURANCE

A quality assurance program is the umbrella program which assures that programs, standards, policies and procedures necessary for the safe operation of the station exist, are documented and implemented in accordance with stated requirements. Historical poor performance in quality assurance has led CNSC staff to include a licence condition for all stations specifying the Canadian Standards Association (CSA) series of standards as the regulatory requirement for quality assurance programs. These standards require that the organization responsible for the plant establish and implement a quality assurance program for the items and services they are supplying. CNSC staff reviews concentrate on the licensees application of these standards. CNSC staff review the licensees ability to demonstrate:

- consistent definition of roles and responsibilities for station programs;
- structured implementation of station programs;
- control of changes and program interactions; and
- internal self assessment and corrective action.

CNSC staff consider that weak performance in quality assurance is reflected in the effectiveness of station programs, and has a negative impact on safety.

At OPG stations, one of the objectives of their major improvement program is to consolidate and simplify business processes and publish them in a set of governing documents. The majority of these documents have been produced and CNSC staff is reviewing them to confirm that quality assurance requirements have been adequately addressed and that they will be properly implemented at sites. CNSC staff has observed acceptable field practices in specific areas of OPG corporate audits and the quality of line staff self-assessments has improved. However, the overall quality assurance program remains conditionally acceptable until CNSC review confirms the acceptability of the new documents and CNSC staff has verified that all processes have been effectively implemented.

In 1999, CNSC staff assessed Point Lepreau quality assurance as unacceptable, however, this year the program is assessed as conditionally acceptable. The change in the rating is based on the improvement plan submitted by Point Lepreau staff and the progress to date against that plan. To move to an acceptable rating, Point Lepreau must continue to demonstrate progress of the development of their quality assurance program. To do this, Point Lepreau staff is working with external consultants to define and document a consistent management structure that will identify the core business processes.

In 2000, CNSC staff evaluated Gentilly-2's procurement process, nonconformance process and corrective action process. These audits identified significant noncompliance with the quality assurance program requirements. In addition, CNSC staff found that Gentilly-2 staff had not implemented effective remedial measures to address directives and action notices from previous audits. However, pending corrective action within the period specified in the licence condition, CNSC staff continue to assess Gentilly-2 in the sub-area of quality assurance as conditionally acceptable.

HUMAN FACTORS

The objective of the human factors program is to ensure that the potential for human error is minimised by adequately addressing factors known to affect human performance, such as:

- organization and management structures;
- policies, processes and job design;
- human machine interfaces, procedures and job aids; and
- physical work environments.

To support the implementation of the human factors program, CNSC staff has recently issued a human factors regulatory policy.

This year, CNSC staff reviews find that there is increasing recognition of the importance of human factors concerns and licensees are implementing a number of initiatives to improve human performance. Therefore, CNSC staff assess the sub-area of human factors as acceptable throughout the industry.

At OPG sites, licensee staff has implemented a system to ensure that human factors issues are considered during the engineering change control process. To monitor the effectiveness of this initiative, CNSC staff reviewed several design modifications, including those associated with the Pickering A return-to-service project, and modifications at Pickering B. At Darlington, CNSC staff completed a review of the human factors program for the shutdown system software redesign project, and concluded that the program positively influenced design decisions, the development of training programs and procedures.

At Point Lepreau, licensee staff continue to develop their human factors program and has appointed a human performance technical advisor. This year, CNSC staff carried out an assessment of New Brunswick Power's new financial incentive program, designed to improve outage performance. This evaluation did not link any safety problems to the new financial incentives.

At Gentilly-2, CNSC staff continued to review the implementation of the 12.5 hour shift schedule for control room operators and have identified the need for improvements to the system for recording hours of work.

ORGANIZATION AND MANAGEMENT

This safety area examines the effectiveness of organizational and management processes and structures that influence the safety performance of a nuclear facility. CNSC staff has developed a method of evaluating certain aspects of a nuclear facility organization from empirical studies which have shown that there are common techniques used by high reliability organizations to manage their safety performance.

In 2000, CNSC staff conducted an organization and management evaluation of Pickering B. The results of the evaluation showed that the station has improved in the management of change for many of its processes. However, the evaluation identified many similar issues as the Darlington station evaluation conducted in 1999, such as, weaknesses in the area of training, including the authorization training, a lack of a formal system for evaluating the effectiveness of implementing new processes and the need for short-term mechanisms to reduce the impact of resource shortages. Although it was concluded that the safety performance at the station was not being compromised, the issues that were identified in the report are being monitored to ensure that future safety performance will be maintained. In addition, CNSC staff continue to review Darlington's improvement plan to ensure it addresses issues identified in their 1999 evaluation.

CORRECTIVE ACTION AND FEEDBACK FROM OPERATING EXPERIENCE

The corrective action and feedback from operating experience (OPEX) program ensures that conditions which are adverse to station safety are identified, analysed for trends, reviewed and corrected. CNSC staff expect licensees to follow the relevant CSA standard in developing their corrective action programs. This standard requires that deficiencies be analysed to determine their causes and corrected to prevent recurrence. It further requires that corrective actions be documented and communicated to appropriate levels of management, and monitored for effectiveness. Also the corrective action program requires the review of events that occur at other nuclear stations to prevent similar problems from occurring at ones' own station.

During 2000, OPG introduced and implemented corrective action and OPEX initiatives to address the issues raised at their stations by 1998 and 1999 CNSC staff audits. This has resulted in the closing of many legacy directives and action notices. Although CNSC staff is still conducting assessment of some field work, and would like to see feedback from maintenance outages improve, CNSC staff assess the sub-area of corrective action and OPEX for OPG sites as acceptable.

At the beginning of the year, Point Lepreau implemented a new corrective action and OPEX program. Throughout the year the station showed improvement in reducing the number of outstanding temporary changes to documentation and systems. However, the new program is still undergoing revision and CNSC staff is also concerned with recurrent failures, such as, those identified during the stations' relief valve re-calibration work. CNSC staff feel that more improvement is needed in this program to ensure that no repeat safety significant events occur. Therefore, CNSC staff assess Point Lepreau in the sub-area of corrective action and OPEX as conditionally acceptable.

In 2000, CNSC staff conducted an audit of the corrective action and OPEX programs at Gentilly-2. The audit found that Hydro-Québec's programs were deficient. CNSC staff raised several directives and action notices to correct these problems. In response, Hydro-Québec is implementing a new process which should ensure that the feedback from both internal and external operating experience is better managed. CNSC staff is currently working with Gentilly-2 staff to ensure that effective actions are taken, so that shortly, compliance with the CSA standards will be achieved. However, CNSC staff continue to assess Gentilly-2 in the sub-area of corrective action and OPEX as conditionally acceptable.

CONFIGURATION MANAGEMENT

Configuration management of a nuclear station is the program that ensures the physical plant is consistent with the design, operating, maintenance and training documentation. Traditionally, CNSC staff has found the licensee configuration management programs under-staffed. Over the past few years, CNSC staff has noted an increase in resources and believe that this is having a positive impact on configuration management problems. At Bruce, a large number of long-standing configuration management problems have been identified and rectified. For instance past changes to systems which were originally inadequately documented are being identified and corrected. However, CNSC staff believe that the impact has mostly been on station documentation and would like to see the same progress on temporary changes made to systems.

CNSC staff find that events related to configuration management problems occurred too frequently. Last year, this led CNSC staff to assess the performance of the Point Lepreau stations as unacceptable. Some improvement has been made in 2000, therefore, CNSC staff assessed the sub-area of configuration management to be conditionally acceptable at all stations, except for Gentilly-2 wich is rated as acceptable.

TRAINING, EXAMINATION AND CERTIFICATION

Licensees must ensure there is a sufficient number of qualified workers available to safely carry out the licensed activity. To meet this requirement, CNSC staff expect the licensees to develop and operate adequate training programs, including testing methods, which provide licensee staff from all relevant job families with the knowledge and skills necessary to safely carry out their duties.

In 2000, CNSC staff assess the safety area of training, examination and certification of staff as conditionally acceptable across the industry.

TRAINING

CNSC staff evaluate the licensee training programs using criteria based on the methodology called *systematic approach to training*. This year, CNSC staff undertook several training program evaluations at various licensee sites. The programs evaluated ranged from mechanical maintenance training at Point Lepreau to system engineer training at OPG sites. Overall, the evaluations conducted showed licensees have made progress toward eliminating weaknesses in training although delays, some significant, in implementing improvements are still being encountered.

At OPG, CNSC staff has found that licensee staff has made substantial progress in defining the training needs of shift supervisor and control room operators candidates. Most issues on this training were resolved during the year and only a few remain before the CNSC will re-instate the supplementary examinations for shift supervisor candidates. CNSC staff review also found OPGs' training information management system was upgraded in 2000 to address difficulties identified in planning and record keeping.

EXAMINATION AND CERTIFICATION

For a number of safety critical positions, CNSC staff assess the competence of licensee staff through the conduct of knowledge-based and performance-based examinations. CNSC staff then certify licensee staff based on the results of these examinations. Before CNSC staff conducts an examination of any type, the licensee must confirm in writing that each candidate has successfully completed the prerequisite in-house training program, which includes a final comprehensive examination.

In 2000, the overall success rate on CNSC examinations for shift supervisor and control room operator candidates was 91%. This represents an increase from the 1999 overall candidate success rate and the average historical overall candidate success rate of 86% as shown in Figure 3.

Figure 3 Historical Candidate Success Rate

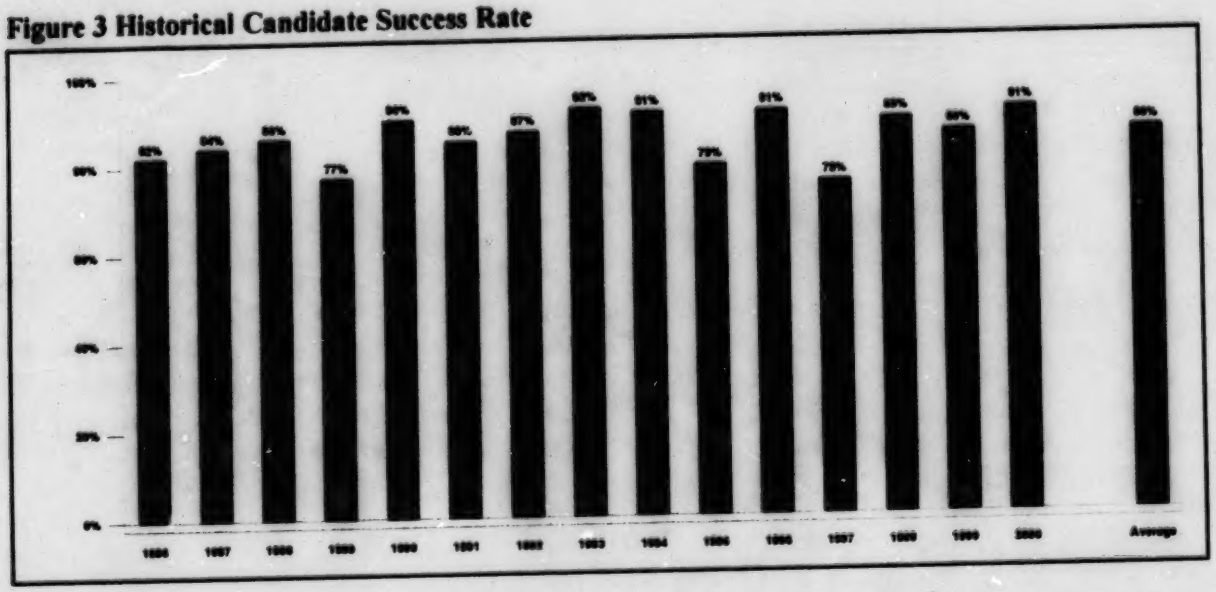


Table 5 provides a breakdown of candidate success rate at each station for which examinations were conducted in 2000. A negative aspect of the examination and certification program has been the inability of the licensees to deliver a valid re-qualification test method for certified staff, although all licensees have been working cooperatively on its development since 1998.

Table 5 Candidate Success Rate on CNSC Examinations in 2000

Station	Written and Oral Examinations Success (In %)	Simulator based Examinations Success (In %)	Overall Success (Number of Passes/Number of Candidates) (In %)
Pickering A	80	100	88
Gentilly-2	No Exams	100	100
Bruce B	94	No Exams	94
Darlington	100	75	90
Pickering B	50	No Exams	50

EMERGENCY PREPAREDNESS

To be able to respond effectively to an emergency, licensees must have an emergency plan, an emergency preparedness program, and must practice and test the response capability of their staff through simulated emergencies. To evaluate the emergency response capability of a nuclear site, CNSC staff assess the emergency plan and preparedness program and the related performance aspects. The assessment of the emergency plan provides an indication of the effectiveness of the emergency response strategy. The review of the emergency preparedness program verifies that all components of the emergency response plan are in place and maintained in a good state of readiness. Finally, the review of the facility's staff response to a simulated nuclear accident provides an assessment of the performance aspects of the emergency response capability.

In 2000, CNSC staff evaluated the emergency preparedness programs and full scale emergency exercises at Bruce, Gentilly-2 and Point Lepreau. CNSC staff found only a few deficiencies from these reviews. The evaluation of the emergency preparedness program at Point Lepreau concluded that New Brunswick Power has improved its nuclear emergency preparedness and demonstrated support for its emergency response program. However, some work remains to be accomplished to address outstanding issues raised this year as well as from a previous inspection. Consequently, CNSC staff assess emergency preparedness at all sites to be acceptable, except for Point Lepreau, which is conditionally acceptable.

ENVIRONMENTAL PERFORMANCE

CNSC regulations require that every licensee take all reasonable precautions to protect the environment and control the release of radioactive and hazardous substances. CNSC staff expect licensees to have programs in place to identify, control and monitor all releases of radioactive and hazardous substances from their stations.

CNSC staff review of environmental performance includes:

- radioactive and conventional waste management,
- effluent and environmental monitoring,
- unplanned releases,
- assessment of environmental protection systems, and
- compliance with provincial environmental regulations.

CNSC staff assess licensees using data on emissions from the stations, through inspections of environmental radiation protection systems and the reviews of associated program documents.

From the review of data on airborne emissions and liquid releases of radioactive substances for all stations, releases to the environment were consistently well below the *derived release limits* (DRL). In addition, doses to the most exposed members of the public were well below the regulatory limit. As in previous years, this continues a strong trend throughout the industry.

In 2000, OPG proposed interim DRLs together with a new methodology for their calculation. The purpose was to bring the calculation of DRLs into compliance with the changes required by the new public dose limits of the *Nuclear Safety and Control Act*. In addition, OPG staff is updating their environmental protection programs to improve environmental performance at their stations.

This year, CNSC staff conducted evaluations of the Darlington and Gentilly-2 off-site radiological environmental monitoring programs. At Darlington the evaluation raised several action notices, however, CNSC staff expect these weaknesses to be corrected when the existing program is replaced with a corporate-wide standard program. CNSC staff found good corporate support and allocation of resources for the transition, but identified some missing aspects to ensure that the program continues to perform satisfactorily. At Gentilly-2, the CNSC staff evaluation raised several action notices related to responsibilities, resources, design documentation, training and quality assurance. Also in 2000, New Brunswick Power submitted its revised radiological environmental monitoring program. CNSC staff is reviewing this document. Therefore, pending resolution of these problems and reviews, CNSC staff assess radiological environmental monitoring programs at Point Lepreau, Gentilly-2 and Darlington as conditionally acceptable, while Bruce and Pickering are assessed as acceptable.

For OPG sites, CNSC staff in consultation with the Ontario Ministry of Environment staff, assessed compliance with the Ontario regulation on effluent monitoring and effluent limits, also known as the *MISA* (Municipal Industrial Strategy for Abatement) Regulation. In 2000, Compliance with monitoring and quality requirements was good at all stations. However, achieving full MISA compliance is still an ongoing issue as OPG continues to initiate further modifications to effluent management where necessary.

REVIEW OF UNPLANNED RELEASES

CNSC staff has a requirement for licensees to report any unplanned releases of radioactive substance or other controlled substance to the environment. In 2000, there were no unplanned releases from any site. Therefore, CNSC staff assess all sites in the sub-area of release of radioactive effluents as acceptable.

RADIATION PROTECTION

Radiation protection is the program that ensures the protection of persons inside a nuclear facility from unnecessary exposure to radiation. CNSC staff require that all radiation exposures are maintained as low as reasonably achievable. Once again in 2000, no worker received a radiation dose in excess of regulatory requirements. CNSC staff review of the industry continues to show that planned doses are effectively managed. Most sites have good control over radiation safety and doses to workers during outages, except for Gentilly-2, where CNSC staff noted weaknesses in Hydro-Québec's staff adherence to radiation protection procedures. All licensees who were inspected have either corrected identified deficiencies or are on target to complete the needed work. Therefore, CNSC staff assess all licensees in the area of radiation protection as acceptable.

NUCLEAR SECURITY

CNSC staff expect that licensees follow the security requirements for their sites as stipulated in the Nuclear Security Regulations. In order to confirm this, CNSC staff review the licensees';

- security guard service, including duties, responsibilities and training;
- written protection arrangements with local response forces and testing of response plans;
- plans and procedures to assess and respond to potential breaches of security; and
- security monitoring and assessment systems and communications equipment.

CNSC staff expect licensees to have a sufficient number of trained and properly equipped security staff available at all times. Furthermore, CNSC staff expect the site to be continuously monitored and for the licensee to take appropriate action for any intrusion. In addition, while not directly specified by the regulations, CNSC staff encourages all licensees to conduct joint security exercises with their respective off-site response forces. These exercises are considered critical to validate the adequacy of station contingency plans, and to test the preparation of both on-site personnel, including security guards, and the off-site response force.

This year, the Bruce and Point Lepreau sites conducted comprehensive security exercises with their respective local police. CNSC staff monitored both exercises and found that they served as an excellent learning tool for management, operational staff and the off-site response forces. In addition, CNSC staff has noticed continued improvements with the physical protection measures at all sites. However, Point Lepreau and Gentilly-2 are still required to correct security deficiencies identified during previous CNSC staff inspections. Therefore, in the area of nuclear security, CNSC staff assess OPG sites as acceptable, while, Gentilly-2 and Point Lepreau remain conditionally acceptable.

SAFEGUARDS

The CNSC is designated by the Government of Canada as the federal organization responsible for implementing measures which Canada has agreed to in its international *safeguards* agreements. Therefore, the CNSC regulatory mandate includes ensuring all licensees conform with measures required by these international obligations. Canada is a signatory to the Treaty on the Non-Proliferation of Nuclear Weapons. Pursuant to this treaty, in 1972, Canada entered into a safeguards agreement with the *International Atomic Energy Agency (IAEA)*. The agreement provides the IAEA with the right and responsibility to verify that Canada is fulfilling its commitments not to develop nuclear weapons or other nuclear explosive devices.

Conditions for the application of the safeguards are contained in the power reactor licence for each facility. For a licensee to comply with safeguards they must provide timely reports on the location and movement of fuel and other required nuclear materials. They must also provide access and assistance to IAEA inspectors for verification, installation and maintenance of IAEA safeguards equipment.

In 2000, a protocol additional to the safeguards agreement between Canada and the IAEA entered into force. The "Additional Protocol" is the most significant change in the international safeguard regime in a quarter century. Among other things, the additional protocol provides the IAEA better physical access to, and information on, the Canadian nuclear fuel cycle. An industry strong point this year, was that all licensees provided the necessary information and modified their access procedures for the additional protocol. They also contributed to Canada's initial declaration under the new protocol.

In 2000, all licensees provided the required IAEA reports and cooperated with the IAEA staff routine inspections, including the design information verification and the annual simultaneous physical inventory verification. Annually, in order to draw its own independent conclusions, the IAEA evaluates the results of its verifications against predetermined inspection goals for fresh, reactor core and spent fuel. The IAEA then informs member states of its conclusions through the IAEA safeguards implementation report. Failure to attain an IAEA inspection goal at a station may thus affect Canada's overall IAEA inspection goals. As shown in Table 6, all stations met the IAEA fresh fuel goals. However, Bruce B, Pickering A and B did not meet reactor core fuel goals and Gentilly-2 did not meet the spent fuel goal. To attain these IAEA goals in the future, the necessary core discharge monitors were recently installed in Bruce B and installation at Pickering is proceeding. At Gentilly-2 problems with the bundle counter prevented Hydro-Québec from attaining the IAEA spent fuel goal; however, remedial actions have been taken to resolve this problem.

Table 6 : IAEA CANDU Fuel Inspection Goals

	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Fresh Fuel	Y	Y	Y	Y	Y	Y	Y
Reactor Core	Y	X	Y	X	X	Y	Y
Spent Fuel	Y	Y	Y	Y	Y	X	Y

Legend: Y = IAEA Goal Attained, X = IAEA Goal Not-Attained

Therefore in 2000, CNSC staff assessed all licensees in the licensing area of safeguards as acceptable.

CONCLUSIONS

Licensees operated their stations safely in 2000.

Based on its assessment activities for the year, CNSC staff assessed the overall performance in the following licensing and safety areas as acceptable across the industry:

- operating performance,
- safety analysis,
- radiation protection, and
- safeguards.

No licensing or safety area or sub-area was assessed as unacceptable. CNSC staff assessment showed licensees improved from the previous year in operating performance, safety analysis, emergency preparedness, radiation protection, environmental performance and nuclear security. All stations maintained their performance in equipment fitness for service, performance assurance, training, examination and certification, and safeguards. Figure 4 shows how CNSC staff assessed each station in the remaining areas of the CNSC inspection program. In the areas and sub-areas assessed as less than acceptable, CNSC staff has identified weaknesses that licensees must correct.

CNSC staff identified industry-wide strengths in:

- station operation,
- technical surveillance,
- outage management,
- non-radiological health and safety, and
- environmental performance.

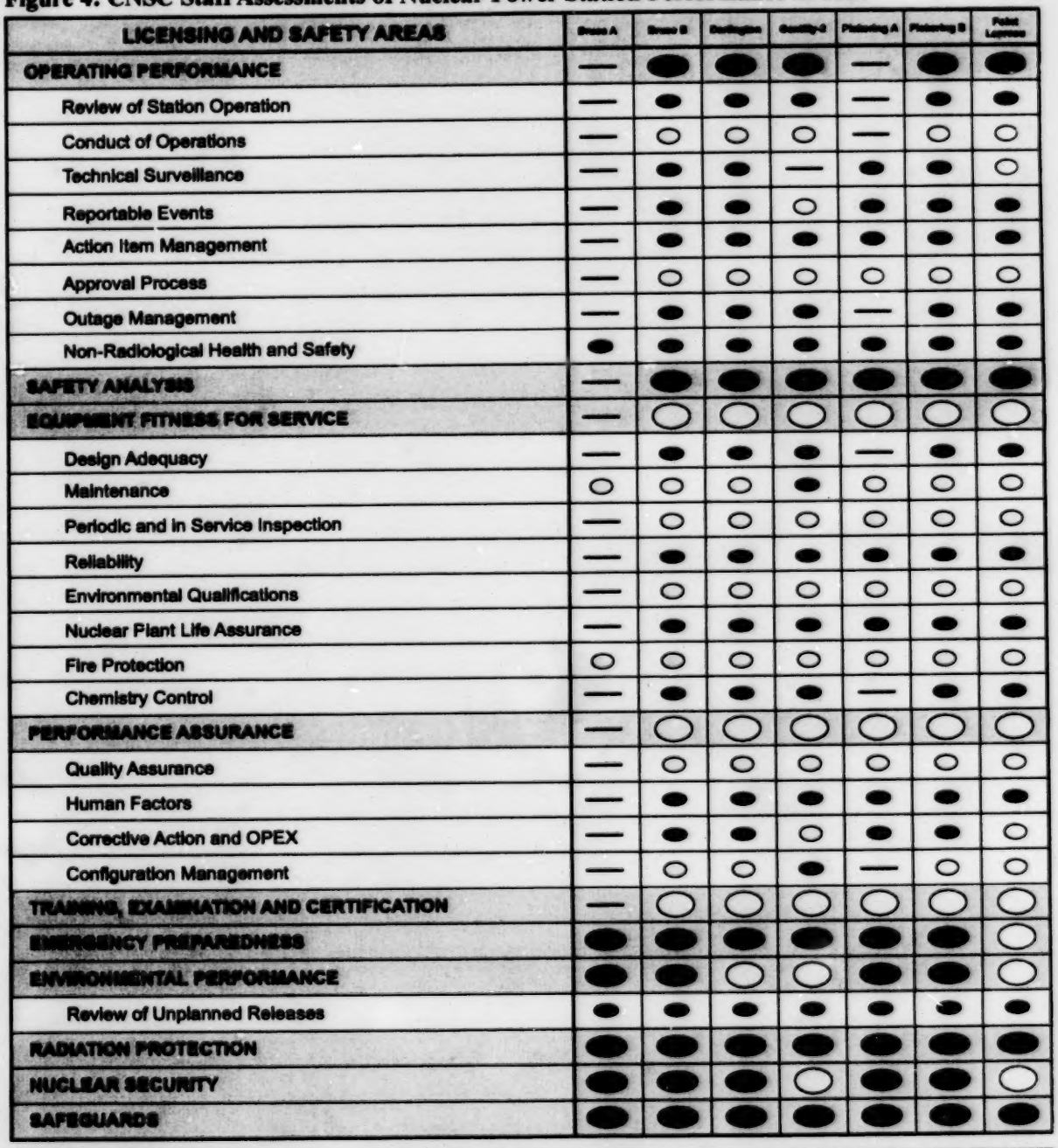
Environmental releases and radiation doses to the public for all stations continue to be well below regulatory limits. As well, there were no reported unplanned releases of radioactive substance or other controlled substance to the environment from any station and no worker received a radiation dose in excess of regulatory limits.

A number of weaknesses common at a majority of stations throughout the industry were:

- backlogs in preventative and corrective maintenance,
- re-qualification test method for certified staff,
- fitness-for-service criteria for pressure tubes, and
- quality assurance.

In most cases, CNSC staff is satisfied with the programs put in place to correct deficiencies.

Figure 4: CNSC Staff Assessments of Nuclear Power Station Performance in 2000



CLOSSARY

commission member documents (CMD)
A CMD is a document the CNSC staff produces in order to comply with the requirements of the *Nuclear Safety and Control Act* and its Regulations. Based on the CNSC staff recommendations presented in the CMD, together with information supplied by the licence applicant and by interest groups or members of the public, the Commission is required to make a decision on whether to approve or reject a licence application.

containment
The building surrounding the reactor. It is designed to contain the effects of any accident involving the reactor, isolating any hazard from the public.

derived release limit (DRL)
A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility such that compliance with the DRL gives reasonable assurance that the regulatory dose limit is not exceeded.

feeder
There are several hundred fuel channels in the reactor. The feeders are pipes that supply heavy water coolant to each channel and return the hot coolant to the steam generators.

fuel channel
A fuel channel consists of a pressure tube which contains fuel, end fittings connecting it to the feeders supplying heavy water coolant, and closure plugs that can be removed by the fuelling machines for refuelling. Each pressure tube is located inside a calandria tube, which separates it from the cold moderator heavy water. Carbon dioxide gas between the pressure tube and the calandria tube provides insulation for the hot pressure tube.

guaranteed shutdown state
A method for ensuring that the reactor is shut down. It includes adding a substance to the moderator which absorbs neutrons and hence removes them from the fission chain reaction, or draining the moderator from the reactor.

heat sink
Any system used to dissipate heat produced in the fuel. At all times, a main heat sink must be in service, normally the steam generators, and an alternative or backup heat sink must be available. Failure to dissipate the heat produced in the fuel by means of an adequate heat sink can increase the temperature of the fuel and thereby damage it.

International Atomic Energy Agency (IAEA)
A United Nations agency, it provides a system of safeguards to make sure that states do not divert nuclear materials to non-peaceful activities. It also provides an international forum for nuclear safety.

layed-up state
The station is placed in a special configuration which prevents system and component degradation during extended periods of shutdown.

MISA (Municipal Industrial Strategy for Abatement)
Ontario Regulation 525/95 "Effluent Monitoring and Effluent Limits – Electric Power Generation Sector" is also known as the MISA Regulation. This is the result of the initiative of the province of Ontario know as the Municipal Industrial Strategy for Abatement.

Nuclear Safety and Control Act
An act to establish the Canadian Nuclear Safety Commission which regulates the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information.

pressure tubes
Tubes that pass through the calandria and contains 12 or 13 fuel bundles. Pressurized heavy water flows through the tubes, cooling the fuel.

regulatory policy statement
These CNSC documents contain firm requirements and guidelines for compliance with regulations. However the CNSC may allow variations, or consider alternative means of attaining the same objectives where a satisfactory case is made.

safeguards
An international program of monitoring and inspection carried out by staff of the International Atomic Energy Agency. Safeguards ensure that nuclear materials in the station are not diverted for non-peaceful uses.

serious process failures
A failure in the stations' components or systems, which is sufficiently serious that one or more of the special safety systems must operate to prevent reactor damage.

setback
A system designed to slowly reduce reactor power if a problem occurs. Setback and stepback systems are part of the reactor regulating system.

steam generator
A heat exchanger that transfers heat from the heavy water coolant to ordinary water. The ordinary water boils, producing steam to drive the turbine. The steam generator tubes separate the reactor coolant from the rest of the power-generating system.

stepback
A system designed to quickly reduce reactor power if a problem occurs. Setback and stepack systems are part of the reactor regulating system.

systematic approach to training
A logical progression from the identification of training needs and of the competencies required to perform a job, to the development and implementation of training to achieve these competencies and to the subsequent evaluation of this training.